

INFLUENCE OF POTASSIUM AND ZINC ON THE GROWTH OF INDEGENOUS CYANOBACTERIA IN LOWLAND RICE FIELD OF BANGLADESH

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The influence of K (0, 20, 40 kg ha⁻¹) and Zn (0, 1, 2 kg ha⁻¹) on the abundance of indigenous cyanobacteria alone and in all possible combinations have been assessed in lowland rice field at 30, 60 and 90 days of transplantation of rice seeding. Lower dose of K (20 kg ha⁻¹) significantly improved the growth of indigenous cyanobacteria at the later stages of growth of rice plant. Similarly, moderate level of Zn (1 kg ha⁻¹) alone was also found to be significantly beneficial for abundance of cyanobacteria. However, highest dose of both the fertilizers and their interactions were assessed to be significantly detrimental for the bacteria concerned.

Keywords : Abundance; Cyanobacteria; Detrimental; Potassium; Rice field; Zinc.

Introduction

The role of indigenous cyanobacteria in rice field is significant for its contribution in atmospheric nitrogen fixation. The growth and abundance of cyanobacteria is dependent on physicochemical condition of the rice field ecosystem. The significant inhibitory effect of added nitrogen on abundance of cyanobacteria has been well established. Similarly, the favorable effect of phosphorus and its synergistic contribution to overcome the adverse impact of nitrogen on growth of cyanobacteria have also been reported¹⁻³. However, literature suggests that the role of potassium and zinc on the abundance of indigenous cyanobacteria is scanty. Reports are available that potassium applied alone caused no effect^{4, 5} or combination with nitrogen and phosphorus resulted suppressive impact on growth of algae in rice field⁶. With these views in mind, an attempt has been made to assess to mode of action of potassium and zinc on the abundance of indigenous cyanobacteria in a traditional lowland intensive rice growing area.

Material and Methods

An experiment was arranged in a rice field during *boro* season using K as MP (0, 20, 40 kg ha⁻¹) and Zn as ZnSO₄·7H₂O (0, 1, 2 kg ha⁻¹) in factorial combination at Nurjahanpur, Brahmanbaria. Half of N as urea (55 kg ha⁻¹) and P as TSP (60 kg ha⁻¹) were applied as basal doses. The rest half of N (55 kg ha⁻¹) was applied at maximum tillering stage of rice plant. The treatment combinations used were K₀Zn₀, K₀Zn₁, K₀Zn₂, K₂₀Zn₀, K₂₀Zn₁, K₂₀Zn₂,

K₄₀Zn₀, K₄₀Zn₁ and K₄₀Zn₂. The mechanically ploughed, watered and leveled field was divided into three blocks. Each block was further divided into nine sub plots. The size of each subplot was 4 m × 3m separated from each other by levy. Nine treatments, in triplicate, were allocated according a randomized block design. The fertilizers were broadcasted as per treatment combinations.

Thirty days old rice seedlings of HYV (BR-28) were transplanted at the rate of 3 seedlings hill⁻¹. The hill to hill distance maintained was 6 inches. Agronomic practices were done accordingly up to maturity of the crop. Quantitative estimation of cyanobacteria was done by following standard method in soil samples (0-5cm) collected at 30, 60, and 90 days of transplantation.

Results and Discussion

Cyanobacterial population was found to be variable due to different doses of potassium and zinc applied alone and in combination at 30, 60 and 90 days of transplantation of rice seedlings recorded in the field experiment conducted at Nurjahanpur in Brahmanbaria district (Table 1).

At 30 days of transplantation, application of potassium (20 kg ha⁻¹) caused a slight increase in the growth of cyanobacterial population over the control from 107.80×10⁴ to 109.00×10⁴ g⁻¹soil and was not statistically significant. Results showed that when potassium was applied at the rate of 40 kg ha⁻¹, cyanobacterial population decreased significantly in growth. Application of moderate dose of zinc (1 kg ha⁻¹) showed a slight increase in the growth of cyanobacterial population. Zinc added at the

Table 1. Effect of potassium and zinc on the growth of indigenous cyanobacteria ($\times 10^4$ g⁻¹ soil) in rice field.

| Treatments | Days of transplantation | | |
|---------------------------------|-------------------------|-----------|----------|
| | 30 | 60 | 90 |
| K ₀ Zn ₀ | 107.80 ab | 132.00 bc | 124.70 c |
| K ₀ Zn ₁ | 109.00 ab | 153.30 ab | 141.00 b |
| K ₀ Zn ₂ | 96.20 bc | 116.30 cd | 101.40 d |
| K ₂₀ Zn ₀ | 109.00 ab | 174.00 a | 161.70 a |
| K ₂₀ Zn ₁ | 115.70 a | 125.00 cd | 74.47 e |
| K ₂₀ Zn ₂ | 87.43 c | 101.80 de | 73.17 e |
| K ₄₀ Zn ₀ | 68.23 d | 82.13 e | 70.83 ef |
| K ₄₀ Zn ₁ | 45.33 e | 58.43 f | 56.17 f |
| K ₄₀ Zn ₂ | 20.87 f | 30.57 g | 27.37 g |

Level of significance, $P = 0.05$.

In a column figures having similar letter (s) do not differ significantly whereas figures with dissimilar letter (s) differ significantly as per DMRT.

rate of 2 kg ha⁻¹ caused a decrease in the number of cyanobacterial population from 107.80×10^4 to 96.20×10^4 g⁻¹ soil significantly showing about 11% reduction in number than that of the control. Results demonstrated that increase in the supply of Zn from 1 to 2 kg ha⁻¹ caused an inhibition of the growth of cyanobacteria accounting up to 11.7%. However, the overall impact of Zn on the growth of cyanobacteria was not statistically significant at all.

Nevertheless, the highest number of cyanobacterial population (115.70×10^4 g⁻¹ soil) was observed when 1 kg Zn ha⁻¹ was supplemented with 20 kg K ha⁻¹. However, this number significantly decreased to 45.33×10^4 g⁻¹ soil when 40 kg K was applied in conjunction with 1 kg Zn ha⁻¹. The lowest number of cyanobacterial population was observed to be 20.87×10^4 g⁻¹ soils in the treatment where the highest amount of zinc and potassium were applied together. Interaction of Zn with highest level of K showed a significant reduction in the number of cyanobacterial population in comparison to the control.

At 60 days of transplantation, the maximum number of cyanobacterial population (174.00×10^4 g⁻¹ soils) was recorded in the treatment having 20 kg K ha⁻¹. The second highest number of cyanobacteria (153.30×10^4 g⁻¹ soil) was observed in the treatment receiving 1 kg Zn ha⁻¹. Similarly the lowest number of cyanobacteria (30.57×10^4 g⁻¹ soils) was enumerated in the plot supplemented with 2 kg Zn and 40 kg K ha⁻¹ combinably.

Moderate dose of Zn was found to be effective in promoting the number of cyanobacteria though not significantly. Contrary to this, the highest dose of Zn exerted an inhibitory effect resulting a significant decrease

in the number of cyanobacteria as compared to lower dose of Zn (1 kg Zn ha⁻¹). Single application of moderate dose of K showed a significantly beneficial effect on the growth of cyanobacteria promoting the number to the maximal among the treatments used in the experiment. However, the supply of highest dose of K significantly discouraged the growth of cyanobacteria reducing the number to the minimal among the single doses of K and Zn applied.

At 90 days of transplantation, the highest number of cyanobacterial population (161.70×10^4 g⁻¹ soil) was recorded in the treatment having 20 kg K ha⁻¹ as was observed in 60 days of transplantation. This showed an increase in growth to 29.67 % than that of the control treatment. Similarly the second highest number of cyanobacterial population (141.00×10^4 g⁻¹ soil) was enumerated in the plot supplemented with 1 kg Zn ha⁻¹. The lowest number of cyanobacterial population (27.37×10^4 g⁻¹ soil), however, was estimated in the plot when 40 kg K and 2 kg Zn ha⁻¹ applied together. The individual application of K and Zn performed significantly to encourage the growth of cyanobacterial population at their lower levels. The higher levels of the fertilizers, however, behaved in an opposite way resulting a significant reduction in the number of concerned cyanobacteria. Interaction of Zn with higher level of K (40 kg ha⁻¹) resulted a depressive effect on the growth of cyanobacterial population showing a significant decrease in their number than the values obtained by their individual performance. This situation was decidedly and significantly worse than the effect of interaction of Zn (1 and 2 kg ha⁻¹) with lower level of K (20 kg ha⁻¹) on the growth performance of cyanobacteria in the rice field.

The single application of K in soil caused a variable effect on the growth of cyanobacteria (Table 1). K (20 kg ha⁻¹) played a significant additive role on the growth of cyanobacteria. However, results of some field experiments in India suggested that potassium applied alone caused no effect on the growth of algae⁵. This apparent contradiction may possibly be due to variation in physicochemical conditions of the soil. Moreover, instead of total algal biomass, only the specific species of cyanobacteria was taken into account in the present investigation which might be also a cause of such variation.

Zn applied up to 2 kg ha⁻¹ influenced the growth of cyanobacterial population significantly only at 30 and 90 days of transplantation. It could be noted that the lower dose of Zn was stimulative to the growth of cyanobacterial population though not significantly. Nonetheless, the highest dose of Zn was found to be detrimental so far the growth of cyanobacteria is concerned irrespective of the counting intervals.

Interaction of lower dose of K with either dose of Zn showed a significant impact on the growth of cyanobacteria. Furthermore, it could be noted that the lower dose of K interacted favorably well with the lower level of Zn to accentuate the number of cyanobacteria significantly over the control only during initial and final samplings. On the other hand, interaction of the highest dose of K with Zn resulted mostly significant inhibition on the growth of cyanobacterial population in rice field.

The sequence of abundance of cyanobacteria in the rice field followed the order: 60 days > 90 days > 30 days of transplantation of rice seedlings. Similarly the maximum flush of algal biomass in rice field was observed between tillering and panicle initiation stage in Senegal⁷. However, in wetland rice fields in India, the density of the biomass was maximal a little later than in Senegal⁸. Nevertheless, during dry season algal density was found to be highest just after heading of the rice crop in the Philippines. This variation in abundance might be due to duration and intensity of light availability⁹.

Moreover, the preponderance of cyanobacteria at 60 days (maximum growth stage) of transplantation of rice seedling irrespective of the treatment combinations might be due to the fact that cyanobacteria are generally sensitive to high light intensities and may be regarded as low light species¹⁰. Furthermore, with transplanted rice, the canopy produced a 95% decrease in light intensities after two months which might also possibly be related to the height of the rice plant i.e. 60 cm plants cut off 90% of light¹¹. Notwithstanding the fact that depending on the

region, the season and the plant canopy, the light intensity reaches the soil-water interface could vary from deficiency to inhibitory levels

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